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A NEW GENUS FOR THE FERN FLORA OF IRAN: *CYRTOMIUM*

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Keywords: *Cyrtomium fortunei, Dryopteridoideae,* Mazandaran, Hyrcanian forest, disjunct area.

ABSTRACT

A stand of *Cyrtomium fortunei* was found by the first author in a natural habitat on the northern slope of the Elburs range in N Iran, Mazandaran Province, growing on sandstone rocks in the Hyrcanian forest. The whole context strongly suggests it to be indigenous there, but phytogeographically this would result in a huge, puzzling disjunction between the known native area in SE Asia and the newly discovered stand.

INTRODUCTION

Cyrtomium C. Presl is a genus of the dryopteridoid ferns, closely related to and sometimes combined with *Polystichum* Roth, or alternatively with the New World *Phanerophlebia* C. Presl, a name of the same date but which is treated as having priority over *Cyrtomium.* Molecular systematics (Yatskievych *et al.* 1988, Lu *et al.* 2005) and karyosystematics (Lu *et al.* 2006) have helped elucidate the classification of the group, now thought to consist of four clades equivalent to *Polystichum, Phanerophlebia,* a group comprising *Cyrtomidictyum* Ching, *Cyrtogonellum* Ching plus some species formerly misplaced in *Polystichum* and *Cyrtomium,* and *Cyrtomium sensu stricto.* The latter, thus redefined, comprises ferns with irregularly scattered sori arising from included veinlets and imparipinnate fronds with a non-pinnatifid terminal segment.

Cyrtomium sensu lato has been monographed twice, by Christensen (1930) who recognised nine species and Shing (1965) who raised the species number to 59. According to recent floristic works (Iwatsuki 1995, Kung 2001) a more realistic number is 35 or less. Except for two species (*C. caryotideum* (Hook. & Grev.) C. Presl, also found on Hawai'i, and *C. micropterum* (Kunze) Ching, which extends to Madagascar and tropical Africa, south to Natal) the genus is confined to S and SE Asia, with a marked centre of diversity in China from where it extends to Japan, Korea, Viet-Nâm, Thailand, India and the Himalaya. The westernmost native occurrences in Eurasia are in Pakistan, W Himalaya, from where three species have been reported: *C. anomophyllum* (Zenker) Fraser-Jenk. (= *C. nervosum* Ching & Shing), *C. caryotideum*, and *C. macrophyllum* (Makino) Tagawa (Fraser-Jenkins 1992, 2008, Kullar 2000).

Two species of *Cyrtomium* are widely cultivated as ornamental pot plants: *C. falcatum* (Sw.) C. Presl and *C. fortunei* J. Sm. Both have become established escapes in various parts of the world with a suitable climate, and either or both are reported as locally naturalised in, e.g., Britain, Italy, the Macaronesian Islands, the southern United States, Hawai'i, and Australia. For *C. falcatum,* diploid, tetraploid and apomictic triploid karyotypes are known, whereas *C. fortunei* appears to be consistently triploid

and apomictic, comprising a number of discernible morphotypes that have been treated as varieties or sometimes species (Iwatsuki 1995).

MATERIAL

Voucher specimens of the Iranian *Cyrtomium* have been deposited in the herbarium, Payame Noor University, Sari, Mazandaran, Iran (PNUS; not yet registered in Index Herbariorum). Duplicates are kept in the Berlin-Dahlem herbarium (B) and the second author's herbarium (now: PAL-Gr). Identification has been checked by comparison with herbarium material from all over the generic range present in Berlin-Dahlem (B) as well as descriptions in the floristic and monographic literature.

RESULTS

Plants belonging to the genus *Cyrtomium* were discovered by the first author on 10 Sep 2010 in a single locality on the northern slopes of the Elburs range, 25 km S of the city of Sari and 8.5 km N of the village of Lajim (Fig. 1-3). *Cyrtomium* had not been recorded from Iran previously (Khoshravesh *et al.* 2009). Specimens sent to the second author for study proved to be typical *C. fortunei,* characterised e.g. by the shape and dimensions of its fronds and pinnae, the irregularly and distantly denticulate pinna margin with minute antrorse to incurved teeth, and the pale, thinly papery, entire indusia (Fig. 4).

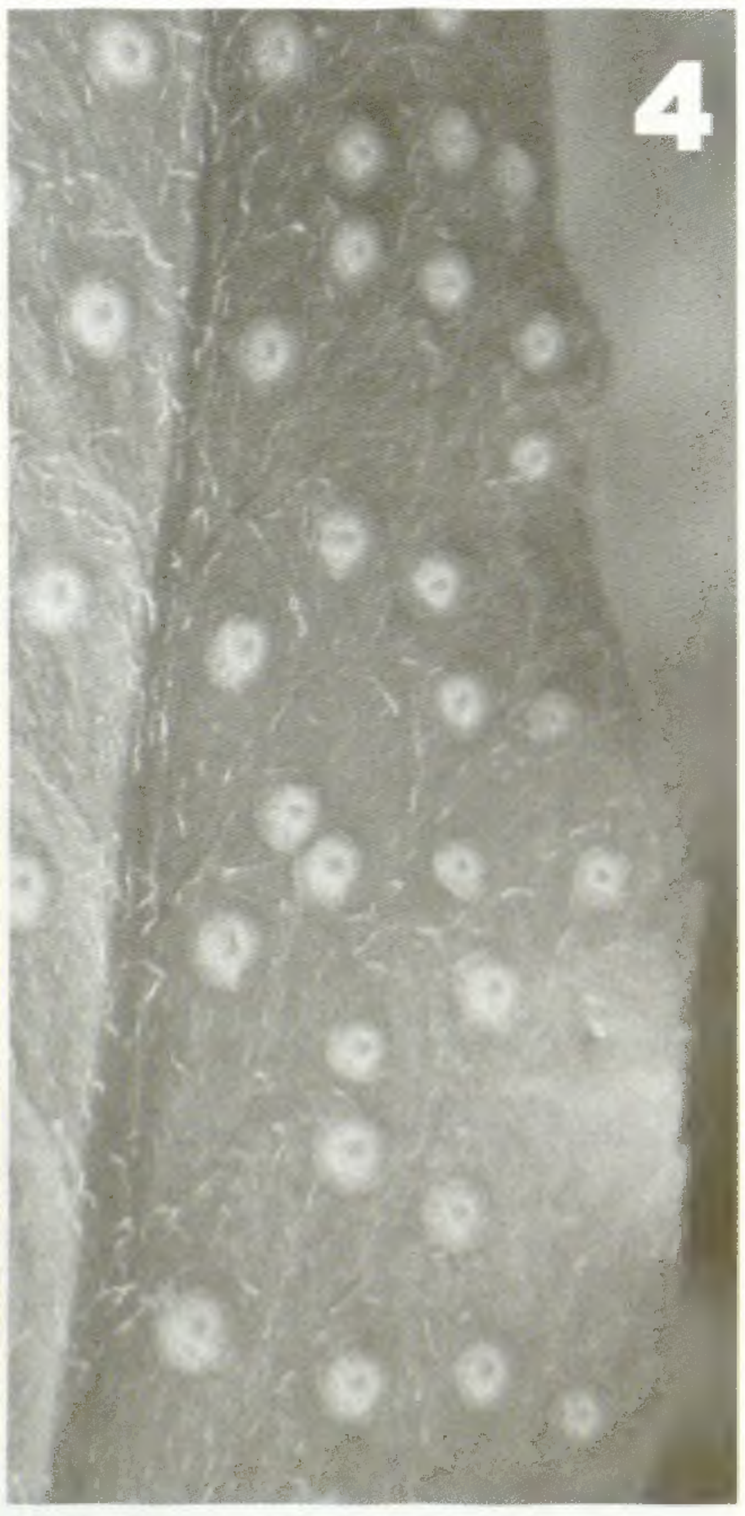
About 30 tufts were observed, scattered over an area of ca. 300 m^2, growing in a small side valley on shaded sandstone rocks, on the trunks of fallen trees and on shallow soil of the valley bottom (Fig. 5). The dominant vegetation was natural Hyrcanian deciduous forest, in which *Carpinus betulus* L. and *Fagus sylvatica* subsp. *orientalis* (Lipsky) Greuter & Burdet predominate, mixed with other characteristic elements such as *Alnus subcordata* C. A. Mey., *Parrotia persica* C. A. Mey., and *Acer velutinum* Boiss. Also, the following fern species were noted: *Asplenium scolopendrium* L., *Dryopteris affinis* (Lowe) Fraser-Jenk., *Polystichum aculeatum* (L.) Roth, and *Pteris cretica* L. The area in question, known locally as "Cron forest", has no protected status.

Label data of the vouchers collected are as follows: Mazandaran, Sari, Aghmashhad, Cron, 36°20′08.2′′ N, 53°05′25.6′′ E, 520 m, 10 Sep 2010, *A. Gholipour 890367* (PNUS, B); same place, 4 Oct 2010, *A. Gholipour 890441* (PNUS, PAL-Gr) (Fig. 6).

DISCUSSION

The so far known native range of *Cyrtomium fortunei* extends from Japan and SE China to S Korea, Viêt-Nam and E Thailand (Iwatsuki 2000). There is a single record (not checked by us) from easternmost India (Manipur: Fraser-Jenkins 2008), which if correct would be the closest known occurrence to our new locality. The distance between Sari and Manipur is ca. 4200 km as the crow flies, roughly the same as that which separates Manipur from Tokyo at the eastern edge of the species range (4500 km). This is a huge disjunction, with the whole Himalayan range and the Iranian highlands lying in-between.

An easy explanation would be to suspect that the Iranian population, rather than being truly native, was brought to its new location by the voluntary action or unintentional assistance of humans. The ease with which cultivated *Cyrtomium* species, in various parts of the globe, escape from cultivation and become established in semi-natural habitats lends credibility to such a hypothesis. For *C. fortunei* proper, naturalised occurrence, while much less generalised than for *C. falcatum,* has been



Figures 1-4. *Cyrtomium fortunei*, photographed in the wild. **1.** Habit (with juvenile *Asplenium scolopendrium* underneath). **2.** Stipe, with large blackish and small fringed scales. **3.** Fertile pinna from below. **4.** Detail of same, showing indusia, indumentum, and crenulate margin. Photography, A. Gholipour.

reliably reported from the U.S.A. (4 states: Yatskievych 1993), SE France, where it enjoys protected status (Salanon 1998), and the southern Alps of Italy (Conti *& al.* 2005).

However, the entire context in which the plants are growing in Iran makes naturalisation an unlikely assumption. The place is literally in the middle of nowhere, and neither at this locality, nor in the surrounding area in general, is there any sign of degradation or indeed of any interference or activity by humans. Weedy, alien species are conspicuously absent. The closest village of note, Aghmasshad, is situated at a distance of ca. 4 km. It does not have any hotel, tourist resort or similar facility in which alien potted plants might be suspected to be grown for amenity. Even more significantly, *Cyrtomium* is not known to be or have been cultivated in Iran, and while its erratic presence cannot be entirely precluded it is definitely not a popular ornamental fern in Iran, nor is it available through the local horticultural trade.

We are therefore of the firm opinion that *Cyrtomium fortunei* is a member of the native Iranian flora. One may of course theorise that it has settled in it current site as a result of natural long-distance dispersal, but if so, there is no way to know when that event may have happened. The Hyrcanian forest of the Elburs range is rich in Tertiary relic species (and genera), and there is no reason to preclude considering *Cyrtomium* as one of their number.

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Ms Sarah Bollendorff, Berlin, kindly produced the scanned specimen image. Brigitte Zimmer, Berlin, assisted with consultation of the Berlin Herbarium. Christopher Fraser-Jenkins provided valuable information on his Pakistani gatherings of *Cyrtomium*.

Figure 5. The native habitat of *Cyrtomium fortunei*, in Mazanderan. Photography, A. Gholipour.

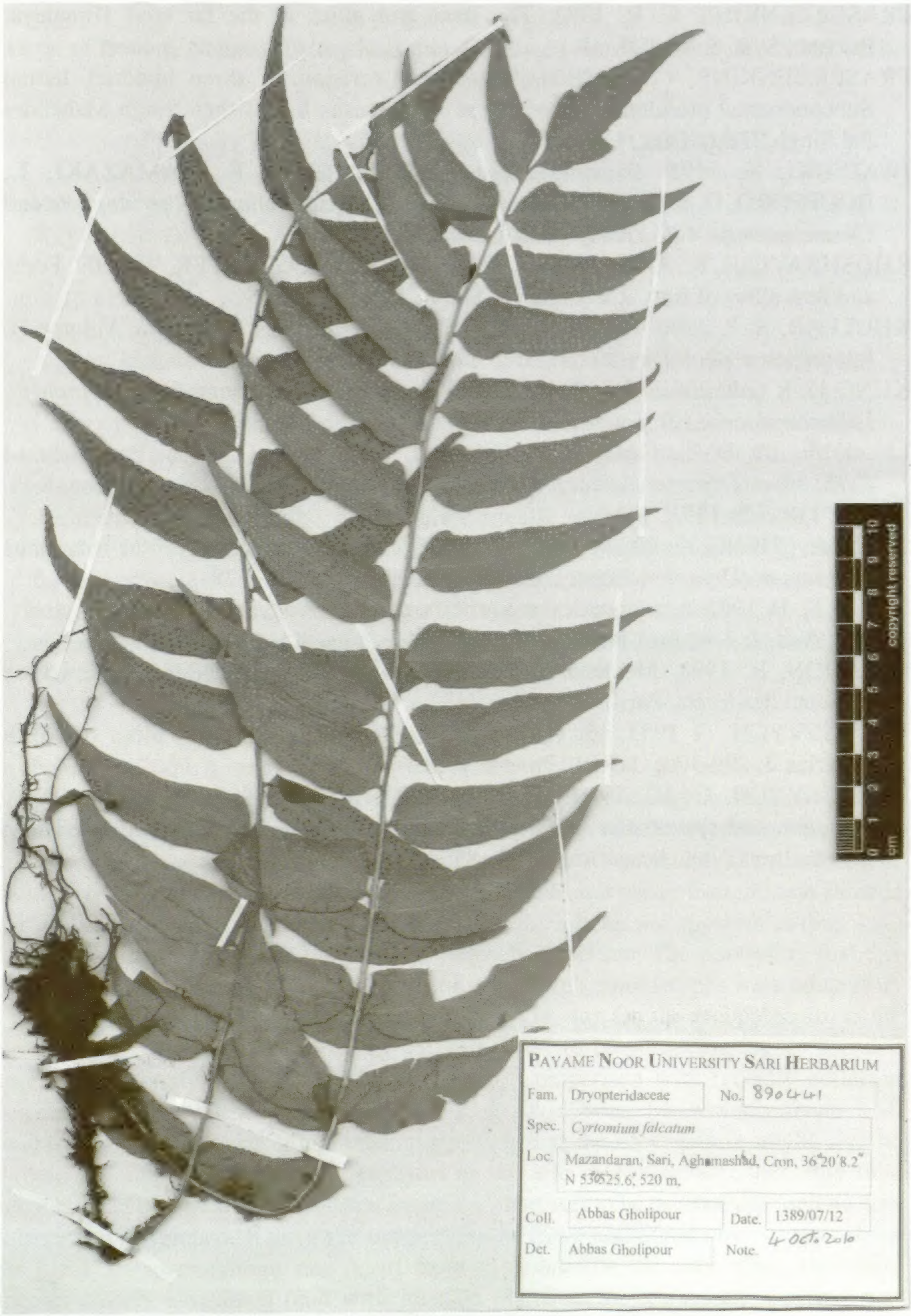

Figure 6. One of the Iranian voucher specimens of *Cyrtomium fortunei*.

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TWO NOVEL *ASPLENIUM* HYBRIDS (ASPLENIACEAE: PTERIDOPHYTA) FROM TENERIFE, CANARY ISLANDS

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Keywords: *Asplenium hemionitis*, *A. aureum*, *A. onopteris*, *A.* × *tagananaense*, hybridization, Macaronesia

ABSTRACT

A plant closely resembling *Asplenium hemionitis* L. but with more dissected, lobed fronds was discovered during a trip to the Anaga mountains, Tenerife, Canary Islands in 2009. This was found to show almost complete spore abortion, indicating a hybrid origin. From the associated species and frond form we suggest the other parent to be *A. onopteris* L. This represents the first documented hybrid of the rather taxonomically isolated *A. hemionitis*. The hybrid, *A.* × *tagananaense,* is described and its distinguishing features given. A further novel *Asplenium* hybrid, photographed in 1995 but not subsequently refound, is identified as that between *A. onopteris* and *A. aureum* Cav. In the absence of a specimen it is not formally described but its distinctive features are illustrated and its occurrence reported.

INTRODUCTION

In February 2009 a small group of pteridologists led by the second author and comprising Alison Evans, Michael Hayward, Tim Pyner and Martin Rickard went to Tenerife. During the excursion, an odd looking fern, which several in the group considered to be an aberrant form of *Asplenium hemionitis* was found. The plant had the palmate frond form unique in the region to this species but closer examination showed the lobes themselves to be more highly dissected, the lobules not apparent as they were largely in the same plane as the frond and closely imbricate. The possibility that this might constitute a hybrid was considered and accordingly photographs were taken (Fig. 1) along with a few voucher fronds (see drawing, Fig. 4a). On the groups' return to the British Isles these were examined by FR and found to be producing highly abortive sporangia, strongly suggesting a hybrid origin. Comparison with recently collected Azorean material of the very rare hybrid *A.* × *rouyi* Viane (*A. scolopendrium* × *A. onopteris*), showed some similarities, suggesting that the other parent might also be diploid *A. onopteris*. The group returned to the site in November 2009, this time accompanied by Patrick Acock. They found the plant still to be present although no new foliage had developed. It gave the opportunity to make additional observations about the plant, its surroundings, etc. Apart from *A. hemionitis* the only other *Asplenium* species closely associated (and with juvenile plants in the immediate vicinity) was found to be *A. onopteris* (Fig. 2).

The possibility that *A.* × *tagananaense* is a hybrid with some other Canarian

Asplenium taxon may largely be ruled out on gross morphological grounds; the only other taxa with an appropriate frond shape are tetraploid and would be expected to show a greater influence on the hybrid frond form because of gene dosage effects (Bennert *et al.*, 1991). *Asplenium* × *rouyi (= A. onopteris* × *A. scolopendrium),* another extremely rare hybrid, only ever found twice (Schäfer & Rasbach, 2000), shares similarities and the *A. onopteris* parent. This hybrid with the entire-fronded *A. scolopendrium*, a very rare plant in the Canaries, differs in its narrower more distinctly triangular frond form, the deeper divisions of the central lobe, the pinnules thus created more nearly at right angles to the rachis. It also appears to have a somewhat fleshier texture common to many *A. scolopendrium* hybrids (Rumsey et al., 2004).

Many years earlier AL had found another curious *Asplenium* on Tenerife which from its morphology (Figs. 3; 4b) could not be matched with any known species, although

Figure 1. *Asplenium* × *tagananaense* – head of Barranco de la Iglesia, Taganana, Tenerife. Feb. 2009. Photo: Alison Evans.

from its texture strongly suggested it may be a hybrid of *A. aureum* Cav., seen growing nearby. A voucher frond was collected and sent to the Department of Botany at the Natural History Museum; most unfortunately its present whereabouts have not been traced. Subsequent visits to the area, by a woodland trail in the hills c. 1km to the west of Erjos, Los Silos (c. 28° 19' 49.35"N 16° 49' 06.77"W) at an altitude of just over 720m, revealed the locality to have changed somewhat in character and the plant could no longer be refound. Photographs taken of the fern when first found, which unfortunately only reveal the upper surface of the fronds, show the plant to be very distinctive, clearly differing from *A. aureum* in its more dissected frond form and in its somewhat triangular shape, the lowest pinnules just the larger. While other taxa within the subgenus Ceterach are now known to occur on Tenerife, both morphological (frond width) and ecological factors indicate that *A. aureum* is involved. Again, on the basis of its morphology, only the 2-3 pinnate, deltate fronded *A. onopteris*, the only other *Asplenium* species seen in the vicinity, could be the other parent. Confirmation will however not be possible until the original specimen or similar wild plants are found.

Few hybrids are known involving members of the morphologically distinctive subgenus Ceterach, although others are inferred in the origin of allopolyploids within this group (Trewick *et al.*, 2002; Van den Heede et al., 2004); most examples of F1 hybrids found in the wild are backcrosses between allopolyploid derivatives and parental taxa (Van den Heede & Viane, 2002). The Canarian endemic *A. aureum* has been demonstrated to

Figure 2. *Asplenium* × *taganaense in situ* with juvenile plants of both putative parents, Nov. 2009. Photo: P. Acock.

Figure 3. *Asplenium aureum* × *A. onopteris* – by forest trail c. 1km West of Erjos, Tenerife, Oct. 1995. Photo: A. Leonard.

be an allotetraploid (Pintér & Vida, 1993). Although its parentage is still uncertain, it is now known to be one parent of the Macaronesian endemic (Madeira, Canaries) hexaploid *A. lolegnamense* Gibby & Lovis (Pintér et al. 2002) and also involved in the origin of the Canarian endemic octoploid *A. octoploideum* Viane & Van den Heede (Van den Heede *et al.*, 2004). The derived polyploid taxa may be more locally abundant than the more mesic *A. aureum*, particularly at altitude but they are more restricted in distribution across the Canarian archipelago.

Some earlier proposed hybrids involving crosses with taxa of other subgenera have subsequently been shown to be in error, eg. *Asplenoceterach badense;* only the hybrid of tetraploid *A. ceterach* L. with the allotetraploid *A. majoricum* (*A.* × *barrancense* (W. Bennert & D.E. Mey.) Pericás & Rosselló) has been cytologically confirmed (Rasbach et al., 1989). However, another very rare example in which *A. aureum* has been suggested to be parental is known (Hansen & Sunding, 1993). *Asplenium* × *newmani* Bolle was described from material collected by C. Bolle in the Barranco del Rio on La Palma in September 1852. It is a simply pinnate fern with fronds only c. 2cm broad, the rachis above green. Known only from the type gathering now in Herbarium Berolinense (B20 0026447), one parent is clearly either the Macaronesian endemic *A. anceps* or, and on ecological grounds less likely, its more cosmopolitan relative *Asplenium trichomanes* subsp. *quadrivalens*. Similar plants have never been refound.

DESCRIPTION

Asplenium × taganananaense F.J. Rumsey **hybr. nov.** (*A. hemionitis* L. × *A. onopteris* L.)

Habitu et textura *A. hemionitis* similis, praecipue frondis plus divisus, lobatus, plus minusve pinnatifidus, basi pinnatilobus, lobo terminali multo magis, sporae abortivus differt.

Holotypus: Canary Islands, Tenerife, Anaga mountains, by track to Taganana near Casa Forestal, at head of Barranco de la Iglesia, amongst rocks by path on steep slope in Laurel woodland, with both putative parents, c. 900m, 28° 32' 43.50" N, 16° 13' 34.50" W, Leonard et al., s.n. 2 February 2009. BM

Perennial from erect-ascending rhizome, leaves flushing annually, wintergreen, coriaceous, glabrous, to 35 cm; petiole 1.5-2.2 x lamina length, somewhat swollen at base, dark reddish brown for most of its length; lamina to c. 15 cm long, 12 cm broad, palmately (3-)5 lobed, the mid lobe distinctly longer, the lobes inconspicuously divided from ¼ to ¾ of their width, the basal more profoundly, lobes with small erect teeth at their apices, the apices sub-acute to obtuse. Sori linear, +/- curved, sporangia failing to mature, spores highly abortive.

Asplenium × *taganananaense* is most likely to be confused with its *A. hemionitis* parent, various frond forms of which have been described from the Canary Islands (Kunkel, 1966; 1967 and see Benl, 1967). While very distinctive amongst European *Asplenium* because of its entire, initially deltate, later palmate frond form, variability exists in *A. hemionitis* and the more markedly lobed and deeply divided forms appear to be more prevalent and perhaps exclusive to the Canary Islands. Rare monstrose forms such as described by Kunkel, 1966; 1967 may be similar in appearance to the newly described hybrid, although they would not show the spore abortion it clearly demonstrates. From the illustration in its original publication f. *cristatum* Kunkel (Kunkel, 1966) is clearly not synonymous; we have seen no material of f. *pinnatipartidum* Kunkel with which to compare our plants.

Figure 4.
A. (right) *Asplenium* × *tagananaense* – underside of frond drawn from Holotype – Leonard et. al., sn. (BM). Scale bar represents 1cm.
B. (left) *Asplenium aureum* × *A. onopteris* – upper surface of frond. Scale bar represents 1cm.

All herbarium material of *A. hemionitis* at BM has been checked and no further examples of *A.* × *tagananaense* have been found. Given its superficial similarity to *A. hemionitis* it may be overlooked but we believe it highly likely that it is genuinely, extremely rare.

Molecular studies based on the sequencing of small portions of the plastid genome, by which the maternal parent can be identified (Vogel et al., 1998), have been initiated but not yet concluded.

DISCUSSION

No hybrids of *Asplenium hemionitis* have previously been reported (Reichstein, 1981; Prelli, 2001). *A. hemionitis* is somewhat isolated within the broad genus *Asplenium*, the only European example of the section Hemionitidastrum Fée (Schneider et al., 2004). Similarly no hybrids of *A. aureum* have been conclusively found (the likely origin of *A.* × *newmani*, found only once in the mid 19th century, still open to debate). Hybridization events involving *A. aureum* are however known to have occurred as inferred from molecular studies of its allopolyploid progeny (Pintér et al. 2002) (Van den Heede et al., 2004). Observations in other pteridophyte groups such as *Equisetum* (Page, 1972) suggest greater levels of hybridization between phylogenetically closer taxa, where speciation has proceeded through ecological, hence physical separation and breeding barriers may not have been so well established. The occurrence of hybrids may thus give some indication of relationships and where apparent inter-generic hybrids are found give cause for taxonomic reconsideration (see recent studies in the Orchidaceae, eg. Bateman, 2006). Generic delimitation within Aspleniaceae has long been contentious with some apparently morphologically distinctive entities, eg. *Phyllitis*, *Ceterach*, *Pleurosorus* traditionally recognised by many authors. Molecular phylogenetic studies (eg. Schneider et al., 2004), are now contributing much to our understanding of the relationships within this highly speciose and taxonomically contentious genus. These studies show that these entities are firmly nested within *Asplenium* and would by their recognition render it paraphyletic. Essentially, if we recognise *Phyllitis* or *Ceterach* then an equally valid case is made for the recognition of other segregates; even the limited British flora would see its 13 species split between 8 genera. As evidenced by the finds reported here, even where phylogenetically distant, rare inter-specific reproductive events may occur, the offspring often instantly threatened by the very combination of factors which have enabled their production. It is potentially these unique combinations of more disparate genomes which are the more likely to promote polyploidy through disrupted cell division and thus fuel the abrupt speciation of very distinctive entities. As such these plants afford us unique insights into evolutionary mechanisms and processes but currently have no conservation standing.

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